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**DEMONSTRATION OF THE 'CHANNEL AERATION  
PROCESS' IN TREATMENT OF SEWAGE, GLENWOOD,  
MINNESOTA**

**Minnesota University  
St. Paul, Minnesota**

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The oxidation channel treatment plant constructed at Glenwood, Minnesota, was set up as a demonstration plant to determine whether or not this process would be more efficient in the removal of nitrogen from sewage than has been the experience with other types of biological treatment. It was felt that with this type of process it would be possible to satisfy the biochemical oxygen demand of the sewage with a minimum amount of oxygen that would maximize (1) the storage of nitrogen in the microbial protoplasm and (2) also release of gaseous nitrogen through denitrification.

The plant at Glenwood, Minnesota, was constructed approximately one year before we had the funds available for the equipping of a suitable laboratory and for systematic studies. The plant was originally designed for a future average daily sewage flow of about 392,000 gallons per day with a population equivalent of about 4,3000 based on a 5-day BOD of the raw waste of 220 mg/l. The present population equivalent of the waste is about 2,700. During the first year of operation before our studies began, the flow fluctuated between 250,000 and 400,000 gallons per day. Soon after the studies were started some leaks occurred in the sewer system that allowed a fairly large amount of fresh water to flow into the sanitary sewer and as a result for the first year of our studies the flow was generally above 400,000 gallons per day usually between 600,000 and 800,000 gallons. With this high flow the final settling tank proved to be inadequate for the removal of settleable activated sludge solids and as a result the BOD removals were unsatisfactory. Also, with this heavy flow it was impossible to control the operations of the plant in such a manner as to effectively study the removal of nitrogen. The City of Glenwood was alerted to these difficulties and as a result a survey of the city sewer system was made during which some important leaks were located and corrected. As a result, the flows since April have been more reasonable but not until the latter part of August were the flows reduced to below 400,000 gallons.

Enclosed with this report is a copy of our first annual report which will describe the results obtained during the first year of our studies. Table I, following, gives some data showing the monthly average of daily flows and the average BOD values of the raw sewage and the final effluent along with the percentage removal since the first annual report was issued. These averages are based upon 15 to 25 determinations of BOD within each month. It can be observed from these data that the average flows did not go below 400,000 gallons per day until August but even with flows as high as 500,000 gallons per day the BOD removals have been very satisfactory. In fact for the months of June through November they have been in excess of 90 percent.

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TABLE I  
MONTHLY AVERAGES

| MONTH     | AVERAGE DAILY FLOWS<br>G.P.D. | BOD RAW WASTE<br>mg/l | BOD EFFLUENT<br>mg/l | % REMOVAL |
|-----------|-------------------------------|-----------------------|----------------------|-----------|
| April     | 609,000                       | 68                    | 14                   | 79        |
| May       | 566,000                       | 91                    | 16                   | 82        |
| June      | 505,000                       | 106                   | 11                   | 90        |
| July      | 425,000                       | 122                   | 7                    | 94        |
| August    | 400,000                       | 144                   | 5                    | 97        |
| September | 343,000                       | 191                   | 7                    | 96        |
| October   | 371,000                       | 199                   | 6                    | 97        |
| November  | 360,000                       | 130                   | 6                    | 95        |

We have, however, encountered some difficulties in our abilities to remove a significant amount of the nitrogen. Because of the heavy infiltration and relatively weak sewage we find it is not possible to so adjust the depth of immersion of the brushes and thus the extent of oxygenation to give adequate velocity to the liquid in the ditch and at the same time obtain the minimum required amount of aeration. If the brushes are immersed deep enough to give adequate velocity to prevent settling of the suspended solids in the ditch we experienced an excessive amount of aeration and build up a fairly large concentration of nitrate which is of course soluble and escapes with the effluent. If the brushes are adjusted so as to give only the minimum required amount of oxygen to reduce the nitrate content the liquid velocity becomes insufficient to prevent settling of suspended solids. The ideal situation in our experience would be to have between 1 and  $1\frac{1}{2}$  ppm of dissolved oxygen in the liquid as it leaves the brushes, and to have this oxygen used up completely before the liquid returns to the brushes again. In fact, it would be desirable to have zero dissolved oxygen for about  $\frac{1}{3}$  of the remaining distance as the sewage approaches the brushes for the second time. During this time the denitrifying microorganism will utilize the oxygen from the nitrate present and therefore more or less reduce the nitrate in the liquid. About  $\frac{1}{3}$  of the nitrogen in this nitrate would escape as nitrogen gas and the other  $\frac{2}{3}$  would be assimilated into the protoplasm of microorganisms.

Table II gives the monthly average values for the nitrate in the effluent and the percentage removal of nitrogen. It can be seen from this that during the months of April, May, June, September, October, and November satisfactory removals were not obtained. However, during the months of July and August respectable removals were possible. During the months of July and August, or least during parts of these months, the depth of immersion of the brushes was deliberately adjusted to a point where they would produce only the minimum amount of required dissolved oxygen. This was possible during the summer months because it was found that during the warm summer months the solids that settled would undergo some fermentation to form gas that would cause them to rise automatically. This generally does not happen so easily during the winter months or during cooler weather. A few days in July and August the brushes were adjusted for immersion of only  $3\frac{1}{2}$  inches and fairly significant removal of nitrogen was obtained.

TABLE II

MONTHLY AVERAGES

| MONTH     | NITRATE PPM IN EFFLUENT | % REMOVAL OF NITROGEN |
|-----------|-------------------------|-----------------------|
| April     | 6.7                     | 19                    |
| May       | 7.6                     | 19                    |
| June      | 4.6                     | 49                    |
| July      | 2.2                     | 76                    |
| August    | 2.0                     | 76                    |
| September | 9.5                     | 54                    |
| October   | 11.6                    | 39                    |
| November  | 16.2                    | 4                     |

Table III shows the data obtained for 17 days during July and August when the brushes were subjected to a  $3\frac{1}{2}$  inch submersion. During these 17 days an average value of 1.05 ppm of nitrate in the effluent was obtained and an average removal of 79 percent of nitrogen. For the balance of the time during the month of July, the brushes were adjusted to a 5-inch immersion which gave an excessive amount of dissolved oxygen and during an 8-day test run at this setting an average nitrate

in the effluent of 4.8 ppm. This was done to show that the results obtained in Table II cannot be explained on the basis of changes in temperature only.

TABLE III

FOR INDIVIDUAL DAYS IN JULY AND AUGUST  
WITH 3½" IMMERSION ON BRUSH

| NITRATE PPM IN EFFLUENT | % REMOVAL OF NITROGEN |
|-------------------------|-----------------------|
| 1.25                    | 80                    |
| 1.65                    | 73                    |
| 1.2                     | 80                    |
| 1.2                     | 82                    |
| 1.6                     | 81                    |
| .95                     | 71                    |
| .55                     | 72                    |
| .00                     | 81                    |
| .31                     | 83                    |
| .45                     | 71                    |
| .40                     | 71                    |
| .20                     | 85                    |
| .08                     | 89                    |
| 2.15                    | 82                    |
| 1.55                    | 83                    |
| 1.7                     | 84                    |
| 1.7                     | 80                    |
| AVERAGE 1.05            | 79                    |

FOR INDIVIDUAL DAYS IN JULY WITH  
5" IMMERSION OF BRUSH

| NITRATE PPM IN EFFLUENT | % REMOVAL OF NITROGEN |
|-------------------------|-----------------------|
| 4.15                    | 61                    |
| 6.2                     | 65                    |
| 5.2                     | 6                     |
| 4.6                     | 44                    |
| 4.6                     | 61                    |
| 3.4                     | 72                    |
| 3.2                     | 74                    |
| 7.2                     | 63                    |
| AVERAGE 4.8             | 55                    |

From these observations it is apparent that if the effectiveness of this process is to be demonstrated it will be necessary to have independent control of (1) the velocity flow in the ditch and (2) aeration. This can be done if submerged propellers are installed and used to impart a velocity to the liquid without introducing reaeration by sucking in any air. These propellers should be operated by variable speed motors. If such equipment can be installed it would then be possible to adjust the depth of the brushes to give only the minimum amount of dissolved oxygen required and yet maintain a sufficient velocity of the liquid in the ditch to prevent settling of suspended solids.

This request for a supplement to the demonstration grant at Glenwood is to permit installation of such equipment. Enclosed herewith is a brief description of such equipment and an estimate of the cost of design and construction. The

cost includes an item for engineering supervision and control to ascertain that the equipment will produce the results required. It is highly desirable that this equipment be obtained in sufficient time so that another year of operation of the plant will be possible where the velocity of the flow in the ditch can be controlled independently from the aeration.

In addition to the removal of nitrogen this study is also concerned with the removal of phosphates. To date it has not been possible to obtain satisfactory data for this part of the study again because of the high flows of the sewage at Glenwood. The city is continuing its efforts to reduce the flow to a normal dry weather flow of 250,000 gallons per day by looking for more leaks of groundwater into the sanitary sewer system and will attempt to correct these when they are found. If the city can accomplish this in the near future, the sewage flow will again return to normal dry weather flow of 250,000 to 300,000 gallons. When this is accomplished we will also be able to get reliable data on the effectiveness of this process for the removal of phosphates.

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